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ONE OPTICAL DESIGN PATTERN/METHOD OF A COST EFFECTIVE IR LENS

INCORPORATION BY REFERENCE

This application claims the priority benefit of U.S. Provisional Patent Application No. 62/398,707 filed on Sep. 23, 2016 entitled "ONE OPTICAL DESIGN PATTERN/METHOD OF A COST EFFECTIVE IR LENS;" U.S. Provisional Patent Application No. 62/485,821 filed on Apr. 14, 2017 entitled "ONE OPTICAL DESIGN PATTERN/METHOD OF A COST EFFECTIVE IR LENS;" and U.S. Provisional Patent Application No. 62/486,383 filed on Apr. 17, 2017 entitled "OPTICAL DESIGN AND METHOD OF MANUFACTURING COST EFFECTIVE IR LENS." Each of the above-identified provisional application is incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

Field of the Invention

The implementations described herein are directed to a novel and improved design pattern/method of a cost effective lens in any partial band of the wavelength range from 1 to 14 micron, this covers SWIR (short wave IR), MWIR (middle wave IR), and LWIR (long wave IR) bands for the IR imaging and/or spectral applications.

Description of the Related Art

In actual lens design, the molded lenses of chalcogenide glasses are used for some thermal imaging/spectral applications for reducing the cost of the lenses. Molded optical elements of chalcogenide glasses are used to control the unit cost in these kinds of applications for the volume production.

However, current designs of IR fixed focal length imaging lenses with one molded optical element of chalcogenide glasses require at least the second optical lens that is a normal lens with normal manufacturing without a further cost control consideration.

SUMMARY OF THE INVENTION

Various examples described herein are directed to novel and improved optical design pattern/method for the cost effective IR lenses for the bands of either SWIR, or MWIR, or LWIR for imaging and/or spectral applications. This method can be used in IR imaging in SWIR band from 1 to 3 micron or a partial band of it, or in the MWIR band from 3 to 5 micron or a partial band of it, or in the LWIR band from 8 to 12 micron or a partial band of it, or any partial band among 1 to 14 micron such as (but not be limited to) 2 to 5 micron. This design pattern/method can also be used in IR spectral application of any partial band of the wavelength range from 1 to 14 micron.

In this design pattern/method, an optical element is a molded lens and this molded optical element has an optical power that is almost the same as the optical power of the whole lens. In this design pattern/method, an optical element is an aberration correction lens with a very small optical power and this optical element needs a very small manufacturing.

In this design pattern/method, the molded lens can be the first optical element while the aberration correction optical element is the second optical element. In this design pattern/

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method, the molded lens can be the second optical element while the aberration correction lens is the first optical element.

In this design pattern/method, the molded lens may be (but not be limited to) one kind of chalcogenide glass. In this design pattern/method, the aberration correction lens may be (but not be limited to) Germanium, or Silicon, or ZnSe, or ZnS, or GaAs.

In this design pattern/method, the molded optical element typically comprises (but not limited to) a spherical surface and an aspheric+diffractive surface or a spherical surface and an aspheric surface. It also can be (but not limited to) two spherical surfaces, or two aspheric surfaces, or an aspheric surface and an aspheric+diffractive surface.

In this design pattern/method, the aberration correction lens typically is (but not limited to) with an aspheric surface and a planar surface. It also may have an aspheric+diffractive surface and a planar surface.

Example 1

An optical design pattern/method of IR lens with a molded lens as the second optical lens and an aberration correction lens as the first optical lens.

Example 2

An optical design pattern/method of IR lens with a molded lens as the first optical lens and an aberration correction lens as the second optical lens.

Example 3

The optical design pattern/method of Examples 1 and 2 wherein said IR comprises any partial bands among 1 to 14 micron, such as (but not limited to) SWIR, MWIR, and LWIR.

Example 4

The optical design pattern/method of Examples 1 and 2 wherein said the molded lens comprises (but not limited to) chalcogenide glasses.

Example 5

The optical design pattern/method of Examples 1 and 2 wherein said the aberration correction lens comprises any IR materials, such as (but not limited to) Germanium, ZnSe, ZnS, Silicon, GaAs, Chalcogenide glasses, CdTe, KBr, CaF₂, BaF₂, MgF₂, and SiO₂.

Example 6

The optical design pattern/method of Examples 1 and 2 wherein said the molded lens comprises any shapes including but not limited to:

- A concave spherical surface and a convex aspheric surface, or
- A concave spherical surface and a convex aspheric+ diffractive surface, or
- A convex spherical surface and a concave aspheric surface, or
- A convex spherical surface and a concave aspheric+ diffractive surface, or
- A convex spherical surface and a concave spherical surface, or